PENDING CLAIMS AS AMENDED

Please amend the claims as follows:

1. (Original) An apparatus comprising:

an oxygen sensor cell for providing an output signal in accordance with an oxygen concentration of a gas within a measuring cell;

a pump cell for adjusting an oxygen ion flow between the measuring cell and ambient air in accordance with a pump current flowing through the pump cell;

a current managing unit for varying the pump current between a first constant current and a second constant current in accordance with the output signal.

2. (Original) An apparatus in accordance with claim 1, further comprising:

a computing device configured to determine an oxygen concentration of the gas based on a pulse width ratio of a square wave of the pump current.

3. (Original) An apparatus in accordance with claim 2, wherein the current managing device is configured to vary the pump current by maintaining the first constant current in a first direction until a first output signal threshold is detected and maintaining the second constant current in a second direction until a second output signal threshold is detected.

4. (Original) An apparatus in accordance with claim 3, wherein the current managing device comprises:

an analog comparator circuit configured to provide a comparator output signal based on the output of the oxygen sensor cell, the comparator output signal indicating when the first output signal threshold is reached and when the second output signal threshold is reached; and

an inverting amplifier circuit connected between the analog comparator circuit and the oxygen sensor cell, the inverting amplifier circuit configured to change the direction of the pump current in response to the comparator output signal.

5. (Currently Amended) An apparatus in accordance with claim 4, wherein the computing device is configured to determine the pulse width ratio by:

measuring a first time period corresponding to the first ~~pump~~ constant current;

measuring a second time period corresponding to the second ~~pump~~ constant current;

determining the pulse width ratio based on the first time period and the second time period; and

determining the oxygen concentration of the gas by comparing the pulse width ratio to a pulse width ratio function for the measuring cell.

6. (Original) An apparatus in accordance with claim 5, wherein the computing device is connected to the comparator circuit, the computing device configured to measure the first time period and the second time period based on the comparator output signal.

7. (Currently Amended) An apparatus in accordance with claim 6, wherein the computing device is configured to determine at least some values of the pulse width ratio function by determining a pulse width ratio for free air, PWM_{AIR}, when the measuring cell is exposed to free air and the first ~~pump~~ constant current is a positive pump current and the second ~~pump~~ constant current is a negative pump current.

8. (Currently Amended) An apparatus in accordance with claim 7, wherein the computing device is further configured to determine at least some of the values of the pulse width ratio function by determining a stoichiometric pulse width ratio, PWM_{ST}, based on a pulse width ratio for free air when the first ~~pump~~ constant current is a positive pump current and the second ~~pump~~ constant current is zero.

9. (Original) An apparatus in accordance with claim 8, wherein the computing device establishes the second pump current by opening an analog switch connected between inverting amplifier and the pump cell in accordance with a negative current cycle.

10. (Original) An apparatus in accordance with claim 9, wherein the oxygen sensor cell is a Nernst cell.

11. (Original) An apparatus in accordance with claim 2, wherein the computing device is configured to determine the oxygen concentration based on a frequency of the square wave.

12. (Original) An apparatus in accordance with claim 11, wherein the computing device is configured to apply a pressure compensation factor based on the frequency to determine the oxygen concentration.

Claims 13-41 (Cancelled).

42. (New) An apparatus in accordance with claim 2, further comprising:
a user interface connected to the computing device.

43. (New) An apparatus in accordance with claim 2, wherein the apparatus is configured to connect to a fuel system for a combustion engine.

44. (New) An apparatus configured to connect to a measuring cell, the apparatus comprising:
a current managing unit configured to receive an output signal based on an oxygen concentration of a gas within the measuring cell and to adjust an oxygen ion flow between the measuring cell and ambient air by varying, in accordance with the output signal, a pump current flowing through a pump cell of the measuring cell between a first constant current and a second constant current.

45. (New) An apparatus in accordance with claim 44, wherein the output signal is produced by an oxygen sensor cell of the measuring cell.

46. (New) An apparatus in accordance with claim 44, further comprising:
a computing device configured to determine an oxygen concentration of the gas based on a pulse width ratio of a square wave of the pump current.

47. (New) An apparatus in accordance with claim 46, further comprising:
a user interface connected to the computing device.

48. (New) An apparatus in accordance with claim 44, wherein the apparatus is configured to connect to a fuel system for a combustion engine.

49. (New) An apparatus in accordance with claim 46, wherein the current managing device is configured to vary the pump current by maintaining the first constant current in a first direction until a first output signal threshold is detected and maintaining the second constant current in a second direction until a second output signal threshold is detected.

50. (New) An apparatus in accordance with claim 49, wherein the current managing device comprises:

an analog comparator circuit configured to provide a comparator output signal based on the output of the oxygen sensor cell, the comparator output signal indicating when the first output signal threshold is reached and when the second output signal threshold is reached; and

an inverting amplifier circuit connected between the analog comparator circuit and the oxygen sensor cell, the inverting amplifier circuit configured to change the direction of the pump current in response to the comparator output signal.

51. (New) An apparatus in accordance with claim 50, wherein the computing device is configured to determine the pulse width ratio by:

measuring a first time period corresponding to the first constant current;

measuring a second time period corresponding to the second constant current;

determining the pulse width ratio based on the first time period and the second time period; and

determining the oxygen concentration of the gas by comparing the pulse width ratio to a pulse width ratio function for the measuring cell.

52. (New) An apparatus in accordance with claim 51, wherein the computing device is connected to the comparator circuit, the computing device configured to measure the first time period and the second time period based on the comparator output signal.

53. (New) An apparatus in accordance with claim 52, wherein the computing device is configured to determine at least some values of the pulse width ratio function by determining a pulse width ratio for free air, PWM_{AIR}, when the measuring cell is exposed to free air and the first constant current is a positive pump current and the second constant current is a negative pump current.

54. (New) An apparatus in accordance with claim 53, wherein the computing device is further configured to determine at least some of the values of the pulse width ratio function by determining a stoichiometric pulse width ratio, PWM_{ST}, based on a pulse width ratio for free air when the first constant current is a positive pump current and the second constant current is zero.

55. (New) An apparatus in accordance with claim 54, wherein the computing device establishes the second pump current by opening an analog switch connected between inverting amplifier and the pump cell in accordance with a negative current cycle.

56. (New) An apparatus in accordance with claim 55, wherein the oxygen sensor cell is a Nernst cell.

57. (New) An apparatus in accordance with claim 46, wherein the computing device is configured to determine the oxygen concentration based on a frequency of the square wave.

58. (New) An apparatus in accordance with claim 57, wherein the computing device is configured to apply a pressure compensation factor based on the frequency to determine the oxygen concentration.

59. (New) An apparatus in accordance with claim 51, wherein the computing device is further configured to perform a calibration procedure by determining at least some factors of the pulse width function.

60. (New) An apparatus in accordance with claim 59, wherein the computing device is configured to determine at least some of the factors by determining a corresponding oxygen

ion flow for a constant pump current when the oxygen sensor cell is exposed to a known gas with a known oxygen concentration.

61. (New) An apparatus in accordance with claim 60, wherein the computing device is configured to determine the corresponding oxygen ion flow by determining a relationship between a Lambda coefficient of the oxygen sensor cell and the pulse width ratio.

62. (New) An apparatus in accordance with claim 61, wherein the computing device is configured to determine the relationship between the Lambda coefficient of the oxygen sensor cell and the pulse width ratio by determining at least two points on a line representing the relationship between Lambda and the pulse width ratio.

63. (New) An apparatus in accordance with claim 62, wherein the computing device is configured to determine at least two points on the line representing the relationship between Lambda and the pulse width ratio by observing a calibration pulse width ratio occurring when the current managing unit directs the pump current in the positive direction until the upper threshold is reached and directs no pump current until a lower threshold is reached.

64. (New) An apparatus in accordance with claim 59, wherein the computing device is configured to perform the calibration procedure by determining a positive corresponding oxygen ion flow for the positive constant pump current and determining a negative corresponding oxygen ion flow for the negative constant pump current when the oxygen sensor cell is exposed to a first known gas with a known oxygen concentration.

65. (New) An apparatus comprising:

a sensor connector configured to connect to a measuring cell and receive an output signal based on an oxygen concentration of a gas within a measuring cell, the output signal produced by an oxygen sensor cell of the measuring cell; and

a current managing unit configured to adjust an oxygen ion flow between the measuring cell and ambient air by varying, in accordance with the output signal, a pump current flowing through a pump cell of the measuring cell between a first constant current and a second constant current.

66. (New) An apparatus in accordance with claim 65, wherein the current managing device is configured to vary the pump current by maintaining the first constant current in a first direction until the output signal reaches a first output signal threshold and maintaining the second constant current in a second direction until the output signal reaches a second output signal threshold, the apparatus further comprising:

a computing device configured to determine an oxygen concentration of the gas based on a pulse width ratio of a square wave of the pump current resulting from the varying of the pump current.

67. (New) An apparatus in accordance with claim 66, wherein the current managing device comprises:

an analog comparator circuit configured to provide a comparator output signal based on the output of the oxygen sensor cell, the comparator output signal indicating when the first output signal threshold is reached and when the second output signal threshold is reached; and

an inverting amplifier circuit connected between the analog comparator circuit and the oxygen sensor cell, the inverting amplifier circuit configured to change the direction of the pump current in response to the comparator output signal.

68. (New) An apparatus configured to connect to a measuring cell, the apparatus comprising:

a current managing unit configured to receive an output signal based on an oxygen concentration of a gas within the measuring cell and to adjust an oxygen ion flow between the measuring cell and ambient air by varying, in accordance with the output signal, a pump current flowing through a pump cell of the measuring cell between a first constant current and a second constant current, the output signal produced by an oxygen sensor cell of the measuring cell; and

a computing device configured to determine an oxygen concentration of the gas based on a pulse width ratio of a square wave of the pump current.

69. (New) An apparatus in accordance with claim 68, wherein the current managing device is configured to vary the pump current by maintaining the first constant current in a first direction until a first output signal threshold is detected and maintaining the second constant

current in a second direction until a second output signal threshold is detected and wherein the computing device is configured to determine the pulse width ratio by:

measuring a first time period corresponding to the first constant current;

measuring a second time period corresponding to the second constant current;

determining the pulse width ratio based on the first time period and the second time period; and

determining the oxygen concentration of the gas by comparing the pulse width ratio to a pulse width ratio function for the measuring cell.

70. (New) An apparatus configured to connect to a measuring cell and to determine an oxygen concentration of a gas within the measuring cell, the apparatus comprising:

a current managing unit configured to vary a pump current flowing through a pump cell of the measuring cell by maintaining a first constant pump current in a first direction until an output signal of an oxygen sensor cell of the measuring cell reaches a first output signal threshold and maintaining a second constant current in a second direction until the output signal reaches a second output signal threshold; and

a computing device configured to:

measure a first time period corresponding to the first constant pump current;

measure a second time period corresponding to the second constant pump current;

determine a pulse width ratio of a square wave of the pump current based on the first time period and the second time period; and

determine the oxygen concentration of the gas by comparing the pulse width ratio to a pulse width ratio function for the measuring cell.